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EXPERIMENTAL INVESTIGATION OF TWISTED TAPE INSERT IN A DOUBLE PIPE HEAT EXCHANGER USING ALUMINIUM OXIDE NANOFLUID

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ABSTRACT

This document reports on the experimental investigation of the features of the heat transfer performance of heat exchanging device with tape insert. The experimental investigation was carried out pipe a warped tape inserted with a proportion of 4.8. An experimental heat flow investigation analyzed using Al_2O_3 water-based Nanofluids was used in this work. The experiment was performed in a turbulent flow situation with a twisted tape of simple water and Nano liquids. Experimental data on plain water and nanofluid was drawn and these informations were used to correlate with plain water and nanofluid. Experimental data were generated with water and nano-fluid for Reynolds in the variety 110000–135460, Nu nanofluid based water. A heat flow features Al_2O_3 and simple stream were improved an augment Re. An experimental data nano fluid was increased by 2.89% compared to the experimental value of plain water. The findings of the inquiry indicate the performance improvement of the parameters of the heat exchanger, namely, the coefficient of heat flow augment by means of amount absorption of the nanoparticle compare with water.

KEYWORDS: Nanofluids, Twisted Tape, Heat Transfer, Aluminium Oxide & Friction Factor

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Original Article

INTRODUCTION

In order to know the mechanism concerned in the thermophysical nanofluids, variety of analyzers have conducted their research on each theoretical and experimental studies. The balanced gold-bearing particles alter convey property and therefore the heat transfer characteristics of the bottom fluid. Analysis was targeted on the preparation of nanofluids exploitation nanoparticles of metal and metal compound. Heat exchangers are used for many industrial and engineering applications to boost the potency of warmth exchanger heat transfer systems. In a plethora of heat transfer apps, their low thermal conductivity has hindered the growth of the necessary energy-efficient heat transfer liquids. The heat transfer properties of these conventional fluids can be significantly enhanced by dispersing nanometer-sized solid particles from the literature survey. Recently, comprehensive theoretical and experimental studies have been attempted which suggest that nanoparticles play an important role in enhancing thermal conductivity by means of microconvection, which is due to the disturbance of thermally driven nanoparticles against base fluid molecules. Heris et al. [1] explored laminar flow Copper and Al_2O_3 nanofluids from side to side a 1 m copper pipe. The evaluation experimental outcome showed the coefficient of heat flow increased by growing the amount portion nanoparticles, over and above even as Al_2O_3 show additional improvement. Yang [2] experimentally evaluated convective heat flow coefficients of more than a few nanoparticle below laminar stream straight pipe. Zhang [3] calculated the thermal conduction and thermal diffusive of Au

toluene, carbon nanotubes-water nanotubes by means of a temporary short-wire method. Chopkar M [5] has been studied in the combination and description of nanofluids for higher heat move applications. Yadav [6] experimental reading of heat transport efficienct double U bend was initiated. Jaafer albadr [7] analyzed the heat flow from side to side a heat exchanger with Al_2O_3 nanofluid at dissimilar attention. Eiamsa ard S [8] conducted an experimental study on heat flow and flow friction round tube fixed with frequently spaced warped strip insert. Murugesan [9] has evaluated the heat flow as well as resistance facial appearance of the flow through square cut with warped ribbon inserts. Pak BC [10] was investigated the hydrodynamic plus heat flow study of detached liquid by means of submicron tinny oxide element.

EXPERIMENTAL INVESTIGATION

A geometric arrangement of pipe by means of width (t) of 0.075 cm, distance end to end (L) of 200 cm use experimental examination. In double tube heat exchanging device, the primary heat move test segment is used, which is protected to reduce the heat defeat to nearby area. It comprises of two pipes which temperate wet flows from side to side the internal tube and cold water flows through the external tube. The external tube is complete of CI with inside and surface diameter 27 mm & 37 mm, respectively. The middle tube is made of AL surrounded by and outer surface diameters of 20 mm & 18 mm correspondingly. Water is filled to the pipe from the water circle, the electrical furnace is prohibited with the voltage regulation agitator and the flow meters are located in pathway of irrigate provide. The organization consists of twin pipe heat exchanger. The inside pipe is made of copper and the exterior tube is shaped of stainless steel. It consists of a water warmer and temperature dimension scheme. The hotness dimension system includes located cove and opening of tubes, in that order.

An experimental set of connections comprises of

- Geyser
- Stress gage
- Indicator of temperature
- Flow meter
- Unit
- Display unit
- Double pipe heat exchanger with twisted
- Hot water
- Line of cold water

Figure 1: Photographic View of Double Tube Heat Exchanging Device.

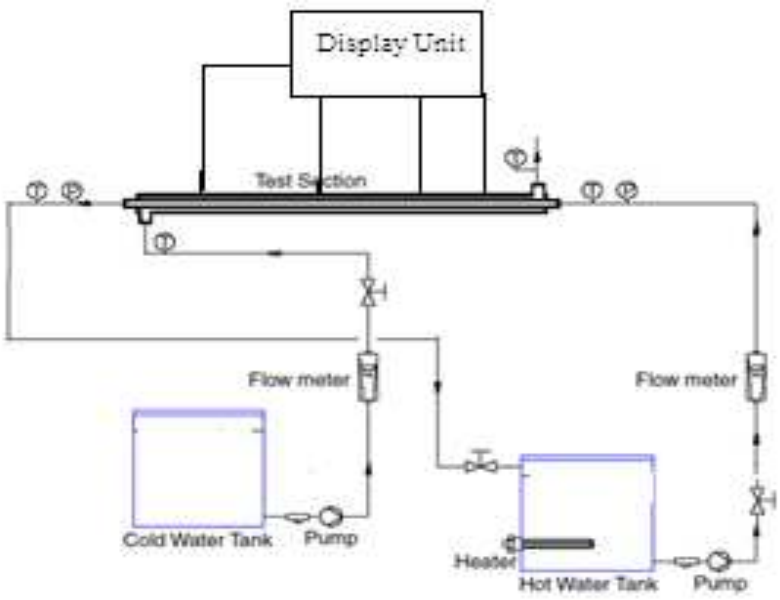

Figure 1(a): Experimental Setup.

Heat flow rate be considered as a result of

$$Q = mCp(T_2-T_1) \quad (1)$$

where

- Q-heat rate
- m-mass flow
- Cp-specific heat
- T-temperature inlet and outlet

Heat transfer coefficient is able to be considered with

$$H = q/(T_w-T_b) \quad (2)$$

where

- h-heat transfer coefficient
- q-heat flux
- T_w-surface temperature

Reynolds number is considered as

$$Re = UD/_v \quad (3)$$

where

- Re-Reynolds number
- U-velocity

- D-Diameter of the tube

  Nusselt number be capable of obtain

  $$Nu = hD/K \quad (4)$$

where

- Nu-Nusselt number
- K-thermal conductivity

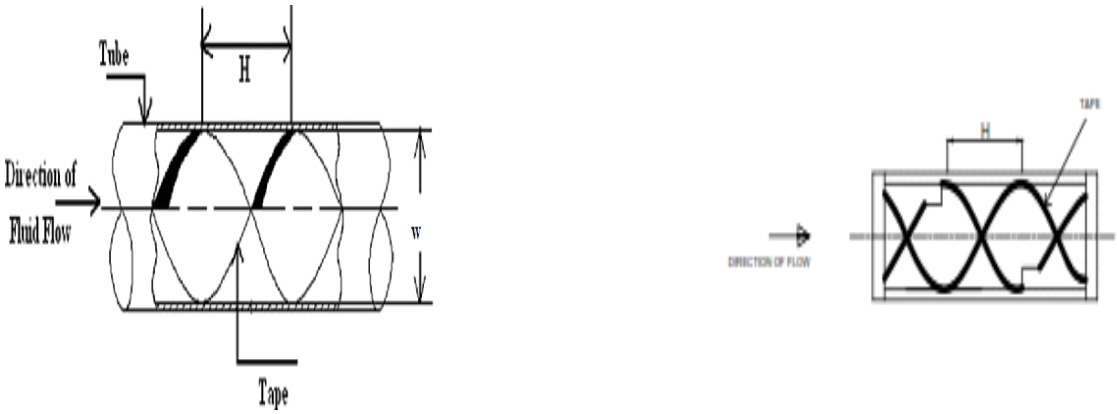

Figure 1(b): Tape Model.

RESULTS AND DISCUSSIONS

Measured heat flow information and friction issue features test outcomes simple water were contrasted with experimental outcomes for nanoliquids. The number of Reynolds varies from 110000 to 135460 with different flow conditions. Figure 2 indicates an evaluation of the amount of Re and Nu with experimental rate pure water with nanoliquids. It is seen that the number of nanofluids in the Nusselt is greater than before by means of an augment Re measure up to plain water. From the surveillance, Nusselt number of the Al_2O_3 nano fluids is 1.1–1.8 times superior to basic water induced. Errors were discovered in percentage between 5% and 7% compared to simple water. Figure 5 demonstrates the difference of Re and h the analog the Nano fluid heat flow coefficient augmented by means of add to Reynolds and give superior standards than plain water transfer coefficient. Due to swirl stream shaped through warped tape, the heat periphery level with the enhanced integration among center and pipe partition were liable to the tapering stream. The assessment of heat flow coefficient of nanofluids augmented 1.06–1.45 times improved with plain water.

An experimental information for friction and the heat flow water nanoliquids variations through the Re of bitter string inserts through a twist proportion of y = 4.8 are exposed in figures 4 and 5 show the rate of heat flow nano fluid better than the water insert. The evident tight ratio produced by means of the nanofluid was greater Than the value heat flow when plain water is inserted. Designed for known number of Reynolds, Nusselt, the rate of heat transfer were enhanced with nanofluid inserts comparable to plain water.

A rate heat flow of nanoliquids increased by 1.2–1.8 times compared to mere water. Figure 5 illustrates a contrast friction factor of Reynolds. The amount of Reynolds increased with a decrease in friction factor owing inserts which created a flowing flow in the pipe; this is primarily owing to the combined impact of the swirling and the turmoil produced alternating cut tape. It will be pragmatic that friction was diminishing by means of 1.56–0.89 times Plain water inserts.

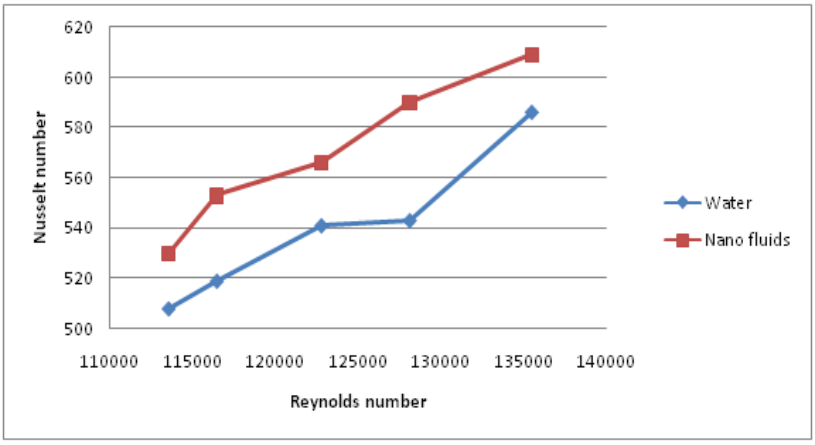

Figure 2: Reynolds Number and Nusselt Number.

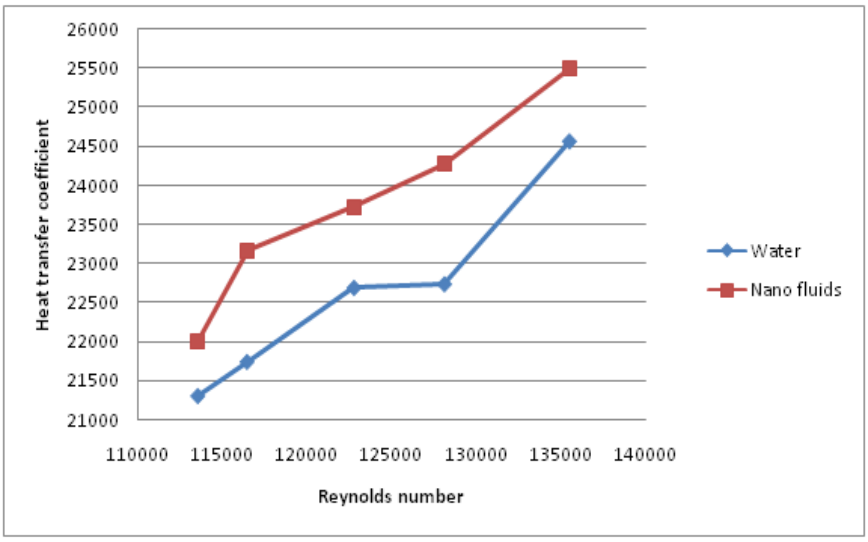

Figure 3: Reynolds Number and Heat Transfer Coefficient.

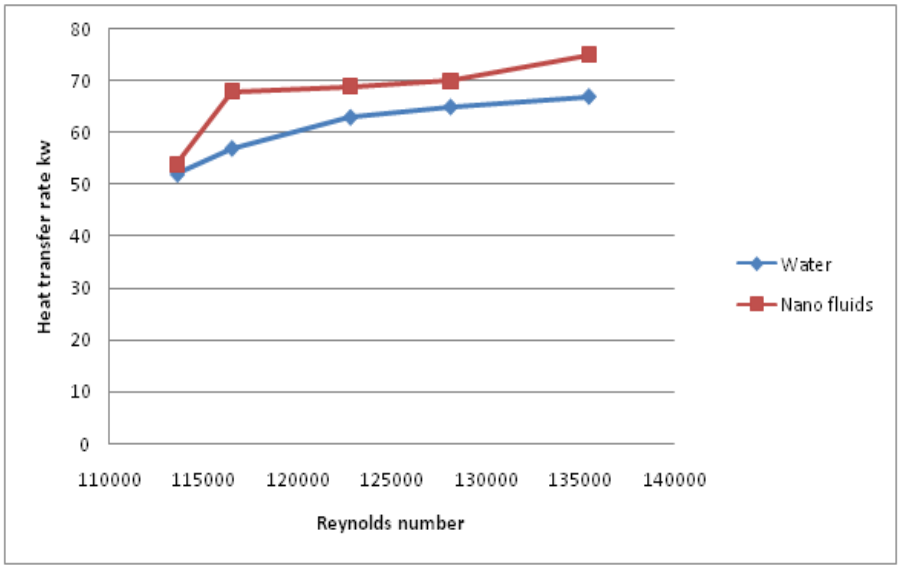

Figure 4: Comparison of Reynolds Number and Heat Transfer Rate.

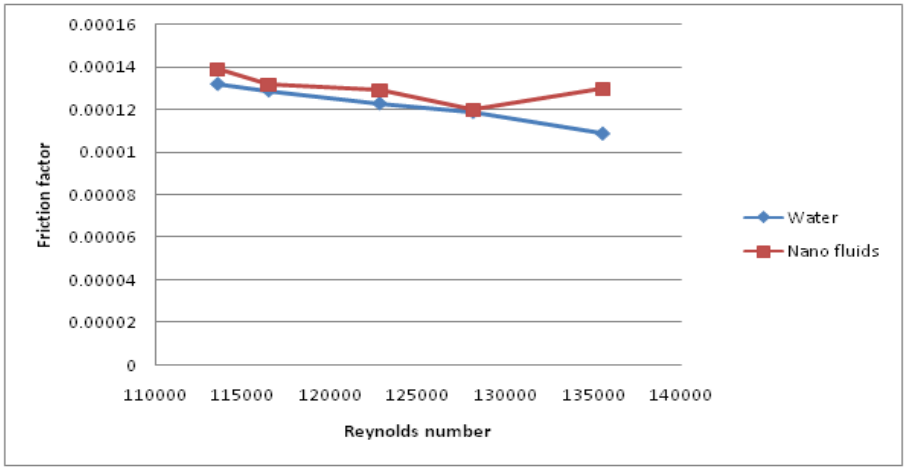

Figure 5: Effect of Friction Factor with Reynolds Number.

CONCLUSIONS

An investigation was conducted by simple water and nano liquids with simple warped strip inserts to measure heat flow rate, Re and Nu. The value with heat flow coefficient, Nu and heat flow rate pipe caused by a plain twisted band of nanoliquids were significantly greater than the data of plain twisted band. An experimental heat flow rate nanofluid data was 20–25% higher than plain water. The findings indicate that the nanofluid provided further heat flow than water with simple tape inserts. A heat flow improvement the tentative record were validated Nano liquid plain water. A friction decreased through rise the amount of Re owing to the fluid flow between the depth of the cut and the tape twist. The amount of Nusselt was rised with an increase Re. An experimental record of Nu was augmented by means of 1.07–1.39 times of experimental outcome of water and nanofluids, heat flow rate augment by choice the best number of Reynolds and ratios. A lower coil ratio employs to operate tape, at any time a greater heat flow rate were needed. A reduced proportion improves the heat flow owing an increase in crossways liquid movement.

Refs. [4, 11–15] are provided in the list but not cited in the text.

REFERENCES

1. *Heris S, Esfahany M and Etemad S G, "Experimental investigation of convective heat transfer of AL2O3/ water nanofluid in circular tube," International journal of heat and fluid flow, 28, No.2, 203–210, 2007.*
2. *Yang Y, Zhang Z G, Grukle A K, AndersonW B, Wu G," Heat transfer properties of nano particles in fluid dispersion under laminar laminar flow," International journal of heat and mass transfer, 48, 1107–1116,2005.*
3. *Zhang X, Gu H, Fujji M," Effective thermal conductivity and thermal diffusivity of nano fluid containing spherical and cylindrical nano particles," Experimental fluid sciences, 31, 593–599, 2007.*
4. *Hamilton R L, Crosser OK," Thermal conductivity of heterogeneous two components system I&EC fundamentals, 1, 182–191, 1962.*
5. *Chopkar M, Kumar S, Bandari D R, Das Pk, Manna," Synthesis and characterization of nanofluid for advanced heat transfer applications," Scripta materialia, 55, 549–552, 2006.*
6. *Yadav A S," Experimental investigation of heat transfer performance of double pipe U bend heat exchanger using full length twisted tape, International Communications in heat and mass transfer, 39, 251–257, 2012.*

7. *Jaafer Albadr, Satinder Tayal, Mustaq Alasadi," Heat transfer through heat exchanger using Al2O3 different concentrations," 1, 38–44, 2013.*

8. *Eiamsa ard S, Thianpong C, Promvonge P," Experimental investigation of heat transfer and flow friction in a circular tube fitted with regularly spaced twisted tape elements," International communications in heat and mass transfer, 33, 1225–1233, 2006.*

9. *Murugesan P, Mayilsamy K and Suresh S. Turbulent heat transfer and pressure drop in tube in tube fitted with square cut twisted tape," Fluid Flow and Transport phenomena 2010; 18: 4: 609–617.*

10. *Kumar, R., Pedgopu, V., Kumar, A. N. I. L., Thakur, R. O. B. I. N., & Pundir, A. N. I. L. (2013). CFD based analysis heat transfer and friction characteristics of broken multiple rib roughened solar air heater duct. Int J Mech Prod Eng Res Dev, 3, 165–172.*

11. *Pak BC, Cho YI," Hydrodynamic and heat transfer study of dispersed fluids with submicron metallic oxide particles," Experimental heat transfer, 11, 151–170, 1972.*

12. *Al-Fahed S and Chakroun W. Effect of tube-tape clearance on heat transfer for fully developed turbulent flow in a horizontal isothermal tube. International Journal of Heat fluid flow; 17:2:173–178.*

13. *Al-Fahed S, Chamra L M, and Chatroun W. Pressure drop and heat transfer comparison for both micro fin tube and twisted tape inserts in laminar flow. Experimental Thermal Fluid science 1998; 18:4:323–333.*

14. *Elhabib, O., Ayad, M., Elmasry, A., & Omar, A. A. Heat Treatment of Wear Particles of Automotive Engines to Determine their Materials from Temper Colours.*

15. *Akhavan-Behabadi M A, Ravikumar, Mohammad pour A and Jamali-Asthiani M, (2009), Effect of twisted tape insert on heat transfer and pressure drop in horizontal evaporators for the flow of R-134," International Journal of Refrigeration 2009; 32: 5:922–930.*

16. *Sivashanmugam P, Suresh S. Experimental studies on heat transfer and friction factor characteristics of turbulent flow through a circular tube fitted with tape inserts. Chemical Engineering process 2007: 46:1292–1298.*

17. *Bodade, P. R., Jogi, N., Gorde, M., Paropte, R., & Waghchore, R. Use of Internal Threads of Different Pitches to Enhance Heat Transfer in a Circular Channel.*

18. *Raj M, Manglika and Arthur E, Bergles. Swril flow heat transfer and pressure drop with twisted tape inserts. Advances in heat transfer 2003; 36: 183–266.*

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